International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Study of the Growth of *Nephrolepis biserrata* Kuntze and Its Utilization as Cover Crop Under Mature Oil Palm Plantation

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Abstract

Nephrolepis biserrata is one kind of weeds in oil palm plantations that have the potential to be used as cover crop. Spreading in the areas of oil palm plantations, this plant should be easy to be planted in other areas related to the utilization of *N.biserrata* as soil cover.

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This study was a field research that included the observation of *N.biserrata* growth and development, as well as the experiment of *N.biserrata* to find out its further potential with regard to its use as cover crop. The study was carried out from November 2013 to September 2014 under mature oil palm plantation with 17-year-old oil palm trees in Cikabayan Experimental Garden, University Farm, IPB, Bogor, West Java. *N.biserrata* Kuntze. can be planted as cover crop under mature oil palm plantations and can grow well after 8 WAP in terms of plant height, number and length of leaves. The planting of *N.biserrata* can improve physical and chemical properties of the soil, making it possible to increase ground water reserves. In comparison, the land not planted with *N.biserrata* experienced an average ground water deficit of 0.26 mm, while the land planted with *N.biserrata* had an *average* surplus of soil water content of 1.33 mm in September 2014. The land planted with *N.biserrata* showed an increase in the element content such as C-organic (12.74%), N (15%), P (26.82%) and K (17:45%) and a decrease in the value of the C / N (2.02%). The planting of *N.biserrata* seemed to be able to reduce the content of clay in the soil by 25.13% and raise the sand and dust content by 5.35% and 148.53% respectively. During the decomposition process, *N.biserrata* could increase the soil nutrient content of N, P, K and C-organic, respectively as high as 41%, 11%, 93%, and 11.3%.

Keywords: *Nephrolepis biserrata* Kuntze; cover crop; oil palm plantation

1. Introduction

The growth and development of a plant species is affected by the habitat where it grows. The plant that has a wide adaptability tends to live in places where other plants cannot grow or can only grow less well. *N.biserrata* Kuntze. is a plant species of ferns that grows wild and has high adaptability. For oil palm plantations, *N.biserrata* is very useful because it can keep the humidity around the plantations.

N.biserrata has properties that enables it to grow in shaded areas, so that it can potentially be used as cover crop in the shaded areas of mature oil palm plantations (TM). Cover crop protect soil surface from disperse power and destructive power by rain drops, slow runoff, enrich soil organic matters and increase soil porosity [1].

Cover crop may be specifically planted to protect the land from the threat of destruction by erosion. In addition, cover crop are also used to improve soil physical and chemical properties both in the system of crop rotation and land rehabilitation system. According to [1], there are some requirements in the use of plants as cover crop and in a crop rotation system, i.e.: (1) not as a competitor for the main crops in the utilization of natural resources; (2) rapid growth; (3) dense and lush condition; (3) ability to compete with other weeds; and (4) not a host of pests and diseases that can attack the main crops.

The study of cover crops under plantation area emphasizes more on their function as soil and water conservation efforts. Cover crops have several functions: to reduce soil density [2], to serve as a place to store carbon [3], to influence soil hydrology, to protect an area from erosion caused by water and wind [4], and to increase the rate of water infiltration [5]. Cover crops play a number of roles as holding or reducing the damage caused by rain drops and surface runoff, increasing soil organic matters, and doing transpiration which reduces the soil water content when soil moisture is high.

Therefore, it is necessary to examine the growth and development of *N.biserrata* Kuntze related to its use as cover crop under mature oil palm plantations so that the benefits can be considered as the activities of cultivation techniques towards sustainable oil palm plantations. Unfortunately, not many references are available related to the use of weeds as cover crop under mature oil palm plantations.

2. Material and Methods

The plant material used in this experiment was *N. biserrata* Kuntze obtained from the area of oil palm plantation. The criteria of plant uniformity were based on plant height.

2.1. The growth of N.biserrata Kuntze.

Studying the growth of *N. biserrata* Kuntze was carried out by observing and measuring the growth parameters of *N. biserrata* Kuntze planted in the media of polybags. This experiment was conducted from November 2013 to February 2014 in the area of Dramaga Cantik, Bogor, West Java.

2.2. The planting of N.biserrata Kuntze.

This research was in form of field experiment using a randomized block design consisting of three treatments with three replications so that there were 9 units of treatments. The treatments were different planting space of 10 cm x 10 cm, 20 cm x 20 cm, 40 cm x 40 cm, with a plot size of 2 m x 2.5 m. The experiment was conducted from March 2014- September 2014 under mature oil palm plantation with 17-year-old oil palm trees in Cikabayan Experimental Garden, Faculty of Agriculture, Bogor Agricultural University, Bogor, West Java.

2.3. Analysis of plant tissue and N. biserrata compost

The levels of tissue nutrients were measured at the end of the experiment by drying the plant materials in an oven at 80° C until reaching a constant weight, then ± 10 g was taken to be finely ground with a grinder to pass 0.5 mm sieve, and finally an analysis was carried out to find the content of N using a persulfate destruction method [6], P using a wet destruction method of 18% perchloric acid followed by Scheel method [7], and K using a wet destruction method of 18% perchloric acid followed by the reading activity using AAS spectra 40 [8].

2.4. Analysis of soil physical and chemical properties

The analysis of soil physical and chemical properties was done at the beginning and end of the study. The measurement of soil physical properties included soil texture, bulk density, porosity, soil permeability, and soil moisture. The measurement of soil texture was carried out by taking soil samples in composite way from several taking points with a soil layer depth of 0-20 cm using a ground drill before the soil moisture and soil texture were analyzed.

The soil texture was analyzed with a pipette method, whereas the soil moisture was measured by weighing the

air-dried soil sample in an aluminum cup with known weight to be finally dried in an oven at 105°C for 24 hours. Next, the cup was removed using tweezers and put into an exicator. After the soil sample was cold, it was weighed and calculated by the equation: Soil Moisture = ((wet soil - dry soil) / dry soil) x 100%.

The measurement of bulk density, porosity and permeability used a sample ring. The bulk density was determined by gravimetric method. When the value of bulk density was obtained, the porosity was then calculated using the equation: Porosity = (1 - (Bulk density / Weight of particles)) x 100%, while the permeability was set in the saturated state based on Darcy's law.

The availability of soil nutrients was analyzed by taking soil in a composite way from several taking points in the upper soil layer of 0-20 cm deep using a ground drill. Then the mixed soil was taken ± 1 kg as soil sample and the analysis of C-organic was performed using Walkley and Black method, N-total (Kjeldhal Method), P (method of 25% HCl extract with spectrophotometer) and K (method of 25% HCl extract with a flamefotometer).

2.5. Measurement of soil water content

The measurement of soil water content was conducted by placing a sensor to measure the content of soil water in a soil depth of 10 cm, 20 cm, 30 cm, 40 cm, and 50 cm. The measurement was done every day, at 7 am, during the time of observation.

3. Results and Discussion

3.1. Plant growth of N.biserrata Kuntze

N.biserrata is one kind of weeds under oil palm plantations that have the potential to be used as cover crop. Spreading in the areas of oil palm plantations, this plant should be easy to be planted in other areas related to the utilization of *N.biserrata* as cover crop. The growth of *N.biserrata* in the oil palm plantations was something overlooked before, considering the plant is considered to be able to grow rapidly in the absence of specific agronomic practices.

At the present, oil palm plantations in Indonesia have started to replant weeds that can serve as cover crop in an organized way so that it is expected to have positive impacts on the growth and development of sustainable oil palm trees. In this regard, it is necessary to examine the growth of certain weeds that will be used as cover crop.

The study of weed growth is very important to be able to estimate an appropriate planting time so that the weed growth can really function as cover crop. Some parameters of plant growth which are important to note in seeking weed species to be used as cover crop included growing power, plant height, number and length of leaves.

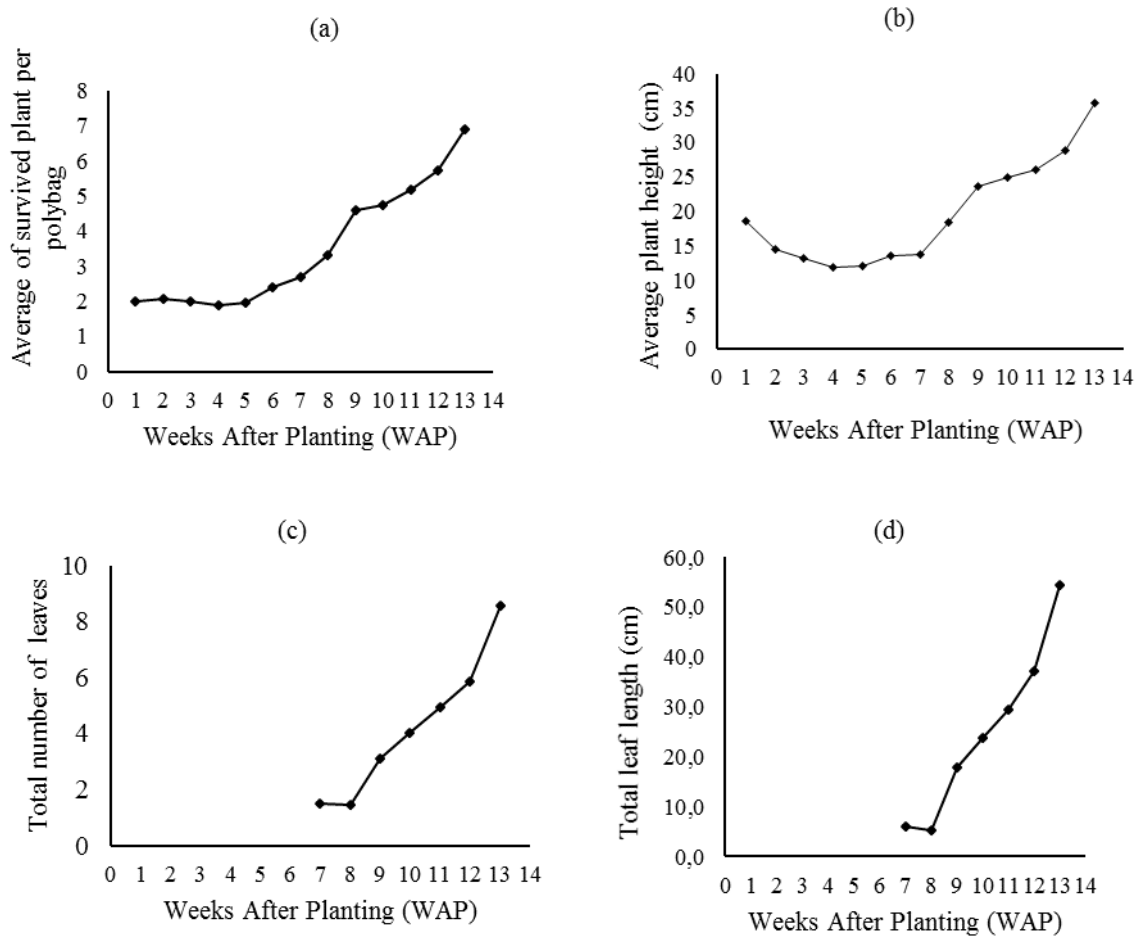

Fig. 1. Average of survived plant per polybag (a), average plant height (b), total number of leaves (c), total leaf length (d)

Fig. 1 shows the growth pattern of *N.biserrata* that includes such parameters as the average number of survived plant per polybag, average plant height, total number of leaves and total leaf length. The four growth parameters can describe the development of plant potential as cover crop. *N.biserrata* plants which are moved to the field will have a different growth pattern compared to the plants left to grow wild, as can be seen in Fig.1, where *N.biserrata* began to grow normally after 7 WAP (Weeks after planting). As cover crop, the plant height, number of leaves, and length of leaves become an important parameter because these have something to do with the ability in covering the soil. *N.biserrata* can serve as cover crop starting from 8 WAP, at the time when the plant height, number of leaves and length of leaves begin to grow well.

3.2. *Soil physical and chemical before and after the planting of N. biserrata* Kuntze

The physical condition of the soil after the planting of *N.biserrata* is described in Table 1. All the parameters of soil physical which were observed indicated that the area planted with *N.biserrata* had an increase in bulk density value and lower porosity and permeability values. In general, the bulk density range from 1.1 to 1.6 g / cc [9]. Soil porosity is the soil property that declares a state of total soil pores that are important to the availability of water and air circulation in the soil [10]. It is understandable that *N.biserrata* plants have many

root systems and high density, making the soil to become denser, the soil pores tend to be less, and most of them have been filled with water. It can be said that there was a high value of water reserves in the area where *N.biserrata* was planted (Fig.2). *N.biserrata* is one of the plants that have more root mass than the mass of the canopy. This situation is advantageous to improve soil texture as illustrated through the comparison of sand, silt and clay. *N.biserrata* seemed to be able to reduce the content of clay in the soil by 25.13%, but it can increase the content of sand and dust respectively 5.35% and 148.53% (Table 1). According to [10], an increase in soil organic matter content due to the presence of plant cover can improve the properties of the soil, such as increasing the resilience of soil structure, soil ability to absorb and retain rainwater, and increasing nutrient elements. In addition, an organic material can bind water six times of its own weight, making its infiltration ability high [11]. It is also able to retain nutrient ions much greater than clay [12].

Table 1. Soil physical under Cikabayan Experimental Garden, Faculty of Agriculture, Bogor Agricultural University

Plot	Bulk dencity (g/cm^3)	Porosity (%)	Permeability (cm/jam)	Sand (%)	Dust (%)	Loamy (%)
Control plot	0.91	65.79	17.62	6.73	13.29	79.98
N. biserrata plot	1.00	62.10	4.93	7.09	33.03	59.88

Plants require a state of good planting media to support growth. *N.biserrata* as a weed in its habitat does not require a specific composition of growing media such as crop cultivation. The study of soil as a growing media in this case is described as a role of *N.biserrata* to change in physical and chemical properties of the soil in the in the areas planted with *N.biserrata*. *N.biserrata* area showed a rise in the element content of C-organic (12.74 %,), N (15%), P (26.82%) and K (17.45%) and a decrease in the value of the C / N (2.02%). This is shown in Table 2. The higher C-organic in the soil planted with *N.biserrata* indicated that the soil contains organic matters that were higher than the soil which was not planted with *N.biserrata*.

Table 2. Soil chemical before and after planted with *N.biserrata* Kuntze

Plot	pH	C-Organic (%)	N (%)	P (ppm)	K (ppm)	C/N
Before planted *N.biserrata*						
Control plot	4.20	2.12	0.2	170	74	10.6
N. biserrata plot	4.20	2.12	0.2	170	74	10.6
After planted *N.biserrata*						
Control plot	4.20	2.15	0.19	129.02	64.56	11.32
N. biserrata plot	4.40	2.39	0.23	215.60	86.91	10.39

3.3. Plant nutrient content of N. biserrata before and after decomposition

The soil condition as a growing media cannot be separated with decomposition activity of material in the soil as a source of soil organic matters. *N.biserrata* is one source of organic matters in the soil, and it is another factor that must be considered in the utilization of *N.biserrata* as cover crop. The C / N of *N.biserrata* before decomposition was 16.53 (Table 3), which means that the plant is easily decomposed to provide nutrients for plants.

Table 3. Plant nutrient content of *Nephrolepis biserrata* before and after decomposition

	pH	C-Organik	N	P	K	C/N
		(%)	(%)	(%)	(%)	
Before decomposition	5.05	31.41	1.9	0.18	2.18	16.53
After decomposition	5.05	27.87	1.12	0.16	0.15	24.88

Increasing the value of C / N that occurs during the process of decomposition indicates that *N.biserrata* will undergo further decomposition with decomposition rate of 1.58 g day. During decomposition process, *N.biserrata* can increase the soil nutrient content of N, P, K and C-organic, respectively for 41%, 11%, 93%, and 11.3% (Table 3). This will be useful for adding nutrients in the oil palm plantations, in general, especially the element of P, where the element is the element that is slow release in the soil.

3.4. Soil water Content during the experiment

The availability of nutrients in the soil cannot be separated from the availability of water that serves, among others, as a solvent in the soil so that nutrients can be available for plants. One of the functions of cover crop is to maintain soil moisture, as indicated by the land not planted with *N.biserrata* experienced an average soil water content deficit of 0.26 mm, while the land planted with *N.biserrata* had an average surplus of soil water content at 1.33 mm in September 2014 (Fig. 2). In September, the rainfall was very small and this could make soil very dry and water deficit could occur, but with the presence of *N.biserrata*, the soil water content reserves was able to be better maintained (Fig.2). In the end, soil water content will affect the growth and development of oil palm so that the presence of *N.biserrata* as cover crop will indirectly have an important impact on the production of palm oil. There was very different rainfall conditions between August 2014 and September 2014. There were more rainfalls in August compared to in September 2014. The planting of *N.biserrata* seemed to be able to produce a dynamic state of good soil water content reserves compared with a non-arable land (Fig.2). The value of water deficit during the observation period was <100 mm, so that in theory it would not significantly decrease the production of palm oil, where the production would fall by 10% if the water deficit was > 100 mm [13].

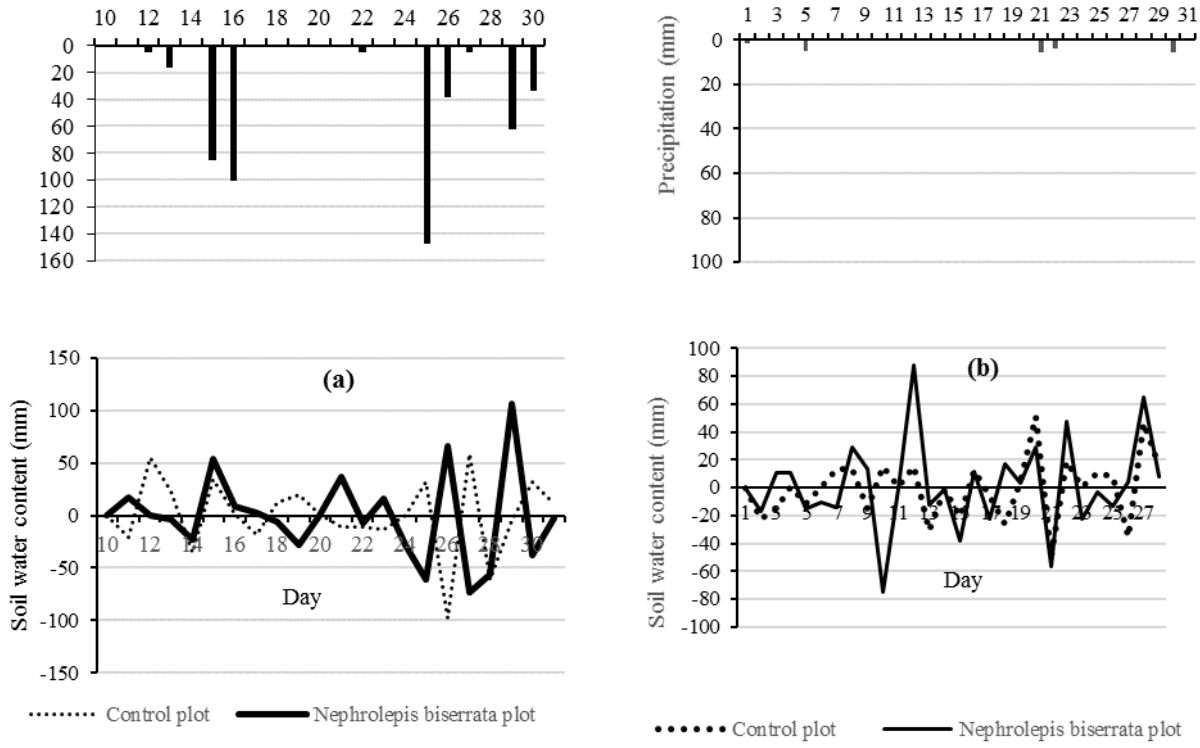

Fig. 2. The soil water content in August 2014 (a) and September 2014 (b)

4. Conclusion

N.biserrata Kuntze can grow as cover crop under mature oil palm plantation and can grow well after 8 WAP in terms of plant height, number and length of leaves. The planting of *N.biserrata* can improve soil physical and chemical properties, making it possible to increase soil water content reserves. This is evidenced by the land not planted with *N.biserrata* experienced an average soil water content deficit of 0.26 mm, while the land planted with *N.biserrata* had an average surplus of soil water content of 1.33 mm in September 2014. The land planted with *N.biserrata* showed an increase in the element content such as C-organic (12.74%), N (15%), P (26.82%) and K (17:45%) and a decrease in the value of the C / N (2.02%). The planting of *N.biserrata* seemed to be able to reduce the content of clay in the soil by 25.13% and raise the sand and dust content by 5.35% and 148.53% respectively. During the decomposition process, *N.biserrata* could increase the soil nutrient content of N, P, K and C-organic, respectively as high as 41%, 11%, 93%, and 11.3%.

Acknowledgments

The authors would like to extend their profound gratitude to the Indonesian Oil Palm Research Institute in Medan, North Sumatera, Indonesia, which has generously funded this research.

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